

WARMING AND VENTILATION,



THE MAHONY
WARMING AND VENTILATING
ESTABLISHMENT,
TROY, N.Y.

A CIRCULAR

ON THE

Warming *and* Ventilation

OF

SCHOOL HOUSES AND CHURCHES

BY

THE MAHONY COMBINATION SYSTEM,

STEAM, HOT WATER OR WARM AIR.

THE MAHONY

WARMING AND VENTILATING ESTABLISHMENT,

MANUFACTURERS OF

HEATING APPARATUS AND CONTRACTORS FOR WARMING AND VENTILATING
PUBLIC BUILDINGS.

M. MAHONY, PROPRIETOR. F. P. SMITH, SUPERINTENDENT.

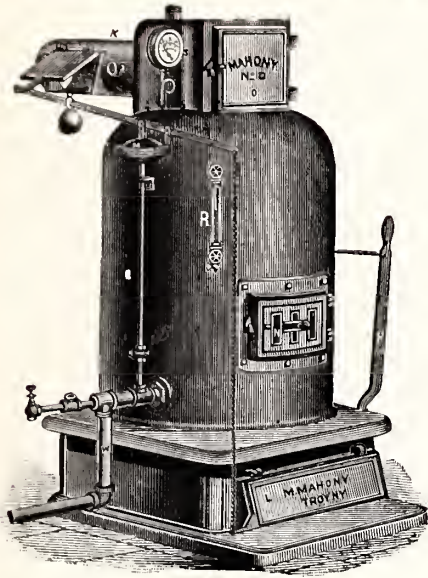
TROY, N. Y.



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Mahony Boiler.



SELF-FEEDING, DIRECT DRAFT BOILER,
FOR STEAM HEATING.

ENTIRELY CAST-IRON.

FOR DIMENSIONS, POWER, ETC., SEE OTHER SIDE.

FOR ✦ SALE ✦ BY

SELF-CONTAINED. REQUIRES NO BRICK SETTING.
HAS NO FLUES TO CLEAN.

DIMENSIONS, HEATING POWER AND PRICE LIST

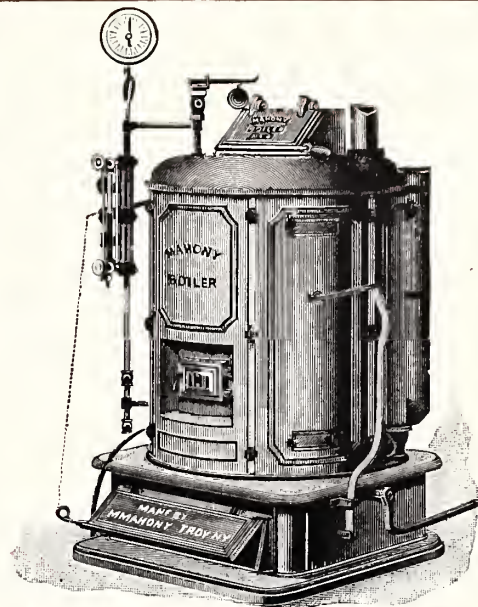
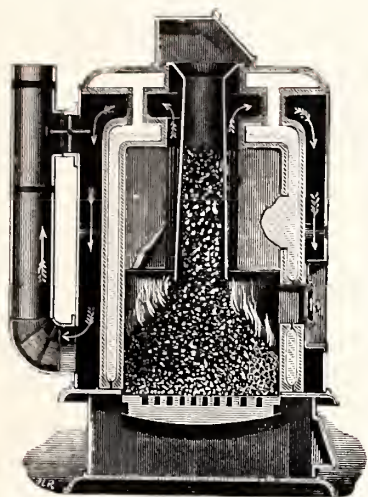
OF THE

MAHONY STEAM BOILER

SELF-FEEDING. WITHOUT JACKET.

SIZE OF HEATER.	Diameter of Fire-Box.	Diameter of Grate.	Height of Heater.	Size of Heater Base.	Height of Water Line from floor.	Weight of Heater Complete.	Heating Power in sq. ft. of surface Direct Radiation.	Heating Power in sq. feet of surface Indirect Radiation.	Size of Steam Pipe.	Size of Return Pipe.	Price. Without Jacket.
	inches.	inches.	inches.	inches.	inches.	lbs.	sq. ft.	sq. ft.	inches.	inches.	
No. 0.....	10	9	51	17 x 20	33	500	100		1¼	1	\$ 50
No. 1.....	13	11½	47	22 x 27	36	750	175		1½	1¼	75
No. 2.....	17	14½	55	26 x 31	39	1000	300	200	2	1½	100
No. 3.....	21	18½	56	29 x 34	40	1400	450	300	2	1½	150
No. 4.....	25	22½	59	34 x 40	43	1900	650	450	2½	2	200
No. 5.....	31	28½	68	42 x 50	49	3000	1000	700	3	2½	250

MAHONY BOILER



SELF-FEEDING, RETURN-FLUE BOILER,
FOR STEAM HEATING.

SIMPLE, EFFICIENT, CHEAP.

FOR DIMENSIONS, HEATING POWER AND PRICES, SEE OTHER SIDE.

FOR ♦ SALE ♦ BY

DIMENSIONS, HEATING POWER ^{AND} PRICE LIST

OF THE

MAHONY STEAM BOILER

SELF-FEEDING, WITH RETURN FLUE JACKET, COMPLETE.

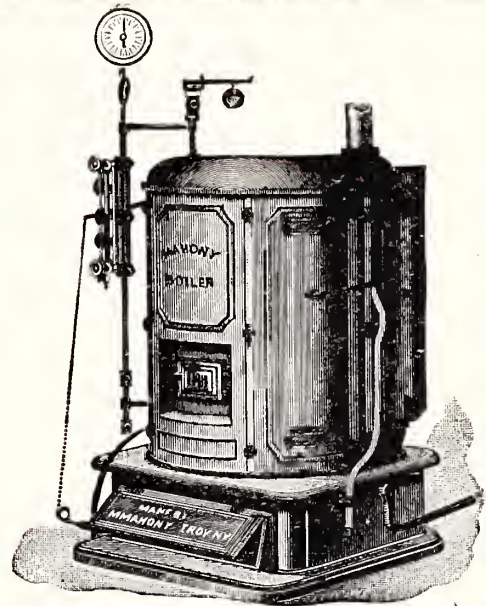
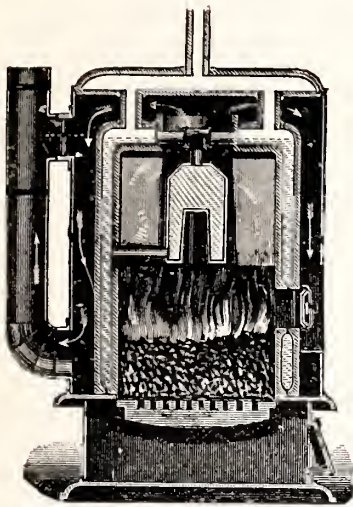
SIZE OF HEATER.	Diameter of Fire-Box.	Diameter of Grate.	Diameter of Jacket.	Height of Boiler.	Size of Boiler Base.	Height of Water Line from floor.	Weight of Boiler Complete.	Heating Power in sq. ft. of surface Direct Radiation.	Heating Power in sq. ft. of surface, Indirect Radiation.	Size of Steam Pipe.	Size of Return Pipe.	Price.
	inches.	inches.	inches.	inches.	inches.	inches.	lbs.	sq. ft.	sq. ft.	inches.	inches.	
No. 0.....	10	9	17	51	17 x 20	33	550	100		1¼	1	\$ 70
No. 1.....	13	11½	20	47	22 x 27	36	800	175		1½	1¼	100
No. 2.....	17	14½	25	55	26 x 31	39	1100	300	200	2	1½	130
No. 3.....	21	18½	30	56	29 x 34	40	1450	450	300	2	1½	190
No. 4.....	25	22½	35	59	34 x 40	43	2000	650	450	2½	2	250
No. 5.....	31	28½	41	68	42 x 50	49	3200	1000	700	3	2½	300

SELF-CONTAINED. VERTICAL FLUE.

CANNOT BECOME CLOGGED WITH SOOT.

REQUIRES NO BRICK WORK.

Mahony Boiler.



SURFACE-BURNING, RETURN FLUE BOILER,
FOR STEAM HEATING

➤ Fire Surface Entirely Effective. ➤

For Dimensions, Heating Power and Prices, See Other Side.

FOR + SALE + BY

DIMENSIONS, HEATING POWER AND PRICE LIST

OF THE

Mahony Surface-Burning Steam Boiler,

WITH RETURN-FLUE JACKET, COMPLETE.

SIZE OF HEATER.	Diameter of Fire-Box.	Diameter of Grate.	Diameter of Jacket.	Height of Boiler.	Size of Boiler Base.	Height of Water Line from floor.	Weight of Boiler Complete.	Heating Power in sq. ft. of surface Direct Radiation.	Heating Power in sq. ft. of surface, Indirect Radiation.	Size of Steam Pipe.	Size of Return Pipe.	Price.
	inches.	inches.	inches.	inches.	inches.	inches.	lbs.	sq. ft.	sq. ft.	inches.	inches.	
No. 0.....	10	9	17	46	17 x 20	28½	550	100		1¼	1	\$ 70
No. 1.....	13	11½	20	41	22 x 27	31½	800	200		1½	1¼	100
No. 2.....	17	14½	25	48½	26 x 31	34	1100	350	200	2	1½	130
No. 3.....	21	18½	30	48½	29 x 34	35	1450	500	300	2	1½	190
No. 4.....	25	22½	35	51½	34 x 40	38¼	2000	700	450	2½	2	250
No. 5.....	31	28½	41	60	42 x 50	45½	3200	1000	700	3	2½	300

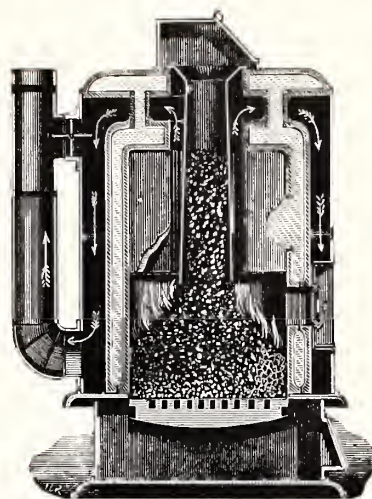
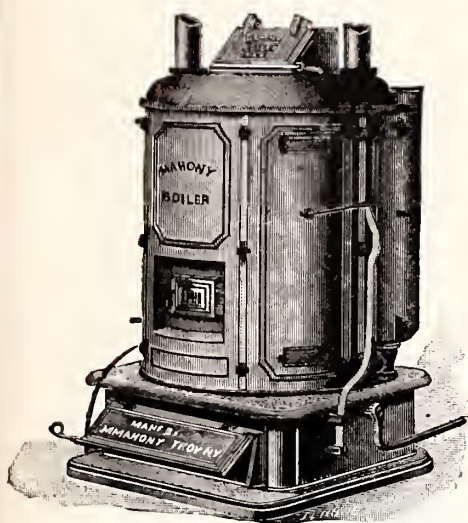
Large Fire Surface.

Small Consumption of Fuel.

Vertical Flues. Easily Cleaned.

Requires no Brick Setting.

Mahony Boiler.



SELF-FEEDING, RETURN FLUE BOILER,
For Hot Water Heating.

IS NOT A SECTIONAL BOILER
AND CANNOT LEAK.

FOR † SALE † BY

SEE OTHER SIDE.

DIMENSIONS, HEATING POWER AND PRICE LIST

OF THE

Mahony Hot Water Heater

SELF-FEEDING, WITH RETURN FLUE JACKET, COMPLETE.

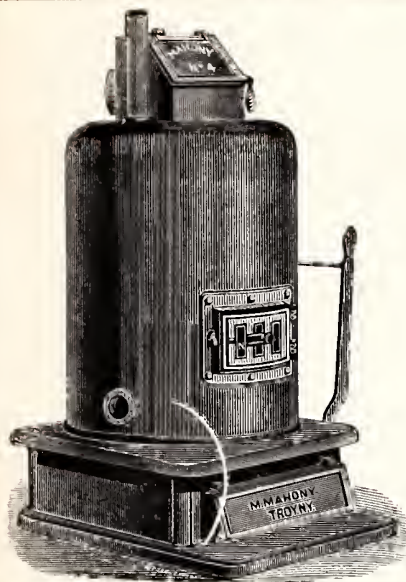
SIZE OF HEATER.	Diameter of Fire Box.	Diameter of Grate.	Diameter of Jacket.	Height of Heater.	Size of Heater Base.	Height of Return Opening from floor.	Weight of Heater Complete.	Heating Power in sq. ft. of surface	Heating Power in feet of One Inch Pipe.	Price with Return Flue Jacket.
	inches.	inches.	inches.	inches.	inches.	inches.	lbs.	sq. ft.	lin. ft.	\$
No. 0	10	9	17	51	17 x 20	12½	550	200	600	60
No. 1	13	11½	20	47	22 x 27	14½	850	300	900	90
No. 2	17	14½	25	55	26 x 31	16½	1200	500	1500	120
No. 3	21	18½	30	56	29 x 34	17	1700	800	2400	180
No. 4	25	22½	35	59	34 x 40	18½	2450	1000	3000	240
No. 5	31	28½	41	68	42 x 50	21	3900	1700	5100	290

Self-Contained. Requires no Brick Setting.

Has no Joints to become Leaky. Vertical Flue.

Cannot become Clogged with Soot.

MAHONY BOILER



SELF-FEEDING, DIRECT-DRAFT BOILER,

For Hot Water Heating.

IS NOT A SECTIONAL BOILER

FOR DIMENSIONS, HEATING POWER AND PRICES, SEE OTHER SIDE.

FOR • SALE • BY

DIMENSIONS, HEATING POWER AND PRICE LIST

OF THE

Mahony Hot Water Heater

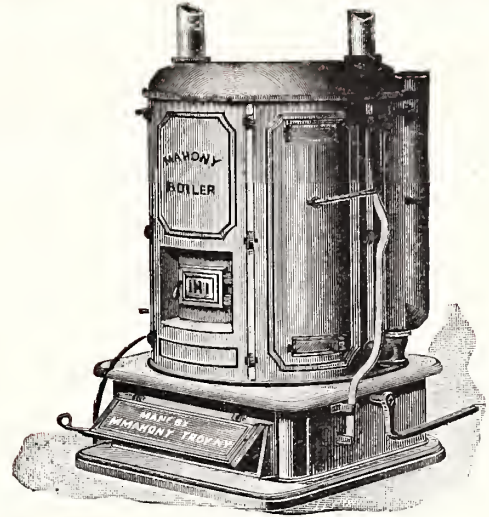
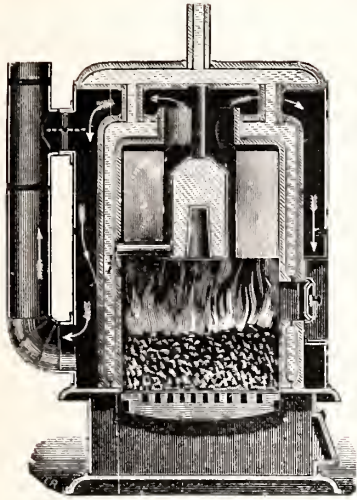
SELF-FEEDING, DIRECT DRAFT, WITHOUT JACKET.

SIZE OF HEATER.	Diameter of Fire-Box.	Diameter of Grate.	Height of Heater.	Size of Heater Base.	Height of Return Opening from floor.	Weight of Heater Complete.	Heating Power in sq. ft. of surface	Heating Power in feet of One Inch Pipe.	Price.
	inches.	inches.	inches.	inches.	inches.	lbs.	sq. ft.	lin. ft	
No. 0.....	10	9	51	17 x 20	12 ½	500	150	450	\$ 40
No. 1.....	13	11 ½	47	22 x 27	14 ½	800	250	750	65
No. 2.....	17	14 ½	55	26 x 31	16 ½	1100	450	1350	90
No. 3.....	21	18 ½	56	29 x 34	17	1600	700	2100	140
No. 4.....	25	22 ½	59	34 x 40	18 ½	2300	1000	3000	190
No. 5.....	31	28 ½	68	42 x 50	21	3600	1500	4500	240

Self-Contained. Requires no Brick Setting.

Has no Joints to become Leaky. Has no Flues to Clean.

MAHONY BOILER



SURFACE-BURNING, RETURN FLUE BOILER,
FOR WATER HEATING.

FIRE SURFACE ENTIRELY EFFECTIVE.

FOR DIMENSIONS, HEATING POWER AND PRICES, SEE OTHER SIDE.

FOR • SALE • BY

DIMENSIONS, HEATING POWER ^{AND} PRICE LIST

OF THE

SURFACE-BURNING

Mahony Hot Water Heater

WITH RETURN-FLUE JACKET, COMPLETE.

SIZE OF HEATER.	Diameter of Fire-Box.	Diameter of Grate.	Diameter of Jacket.	Height of Heater.	Size of Heater Base.	Height of Return Opening from floor.	Weight of Heater Complete.	Heating Power in sq. ft. of surface	Heating Power in feet of One Inch Pipe.	Price.
	inches.	inches.	inches.	inches.	inches.	inches.	lbs.	sq. ft.	lin. ft.	
No. 0.....	10	9	17	46	17 x 20	12½	550	200	600	\$ 60
No. 1.....	13	11½	20	41	22 x 27	14½	850	330	1000	90
No. 2.....	17	14½	25	48½	26 x 31	16½	1200	600	1800	120
No. 3.....	21	18½	30	48½	29 x 34	17	1700	1000	3000	180
No. 4.....	25	22½	35	51½	34 x 40	18½	2450	1200	3600	240
No. 5.....	31	28½	41	60	42 x 50	21	3900	2000	6000	290

Small Water Space. Rapid Circulation.

Large Fire Surface.

Economy of Fuel. Easily Cleaned.

PREFACE.

THE principal purpose of this book is to call the attention of Architects, Boards of Education and Officers of Churches to the apparatus we manufacture, and the systems we use for Warming and Ventilating School Houses and Churches.

Our claims for consideration are simply these : We manufacture the apparatus necessary for successfully introducing our systems, and we guarantee that all contracts taken by us shall be filled to the satisfaction of the Architect or other person or persons with whom the contract is made.

All responsibility for the success of our work and all risk of failure, or expense entailed by reason of failure of our system to work as represented, is, by express terms of contract, assumed by us. We will undertake the warming and ventilation of all classes of school houses or churches, by either *steam, hot water, or warm air, or by combination of steam and warm air, or hot water and warm air.*

It does not make the slightest difference to us, in the matter of profit, which system we use to secure the heat, on which depends the ventilation.

We are at liberty, therefore, to correctly state the merits and demerits of each system without fear of prejudicing our own interests. Whatever system may be used for heating, there must be a very large volume of air warmed for ventilating purposes, and, if it is true, as claimed by many, that there is difficulty in *heating* certain rooms of a building in windy weather with furnaces, it is no less true that there is just as great practical difficulty experienced in *ventilating* a school house or church where steam or hot water are used. The difficulties are exaggerated in both cases and can be readily overcome by those who understand the cause of the trouble.

It is because there are difficulties met with in the introduction of *every system*, whether it be steam, hot water or warm air, that the work should never be entrusted to persons who have neither the education necessary to enable them to make the requisite calculations for planning a system of ventilation nor the experience on which alone good judgment can be based.

We make a specialty of school house ventilation, and whether we understand our work or not, we are willing to make a contract to obtain certain specified results which very few firms care to sign. If we did not *know* from past experience that we were working on correct principles, we could not afford to assume the responsibility we do when we make our contracts.

We desire to correspond with those interested in warming and ventilating school houses and churches.

We draw plans and specifications for heating and ventilating buildings, and will furnish the same for a reasonable consideration. No charge will be made for the plans furnished where we are given the contract for performing the work.

When the erection of new buildings or the introduction of new heating and ventilating apparatus is contemplated, we shall be glad to call, upon request, to consult with those in charge, concerning the heating and ventilation.

Respectfully,

THE MAHONY HEATING AND VENTILATING ESTABLISHMENT.

THE MAKING OF CONTRACTS

for warming and ventilating School-houses and Churches, is too frequently delayed until the contracts for erecting the building have been let, when it is often too late to introduce any system in the best manner, without alterations in plans and consequent annoyance.

The contract for the heating and ventilation should be let just as soon as the general plan and size of the building have been decided upon, and the contractor for the work should prepare the plans and specifications for the construction of the necessary chimneys, flues, etc., and these should be included in and become a part of the regular plans and specifications furnished by the architect.

How to secure good results.—Most committees take the course least likely to secure satisfactory results. After the building is otherwise completed it is the frequent, if not general practice, to advertise for bids for the heating and ventilation, with the understanding that the lowest bidder shall receive the contract. Each one is generally permitted to furnish what he pleases, the only question the committee are interested in being, “who will do the job the cheapest.”

Thus, stove dealers, tinsmiths, and plumbers are often permitted to compete for the contracts, and their bids are considered, though they may not understand the simplest principles of ventilation, or be in any way fitted to do work requiring education, skill and good judgment.

Since the lowest bidder is to get the contract, it is natural that each one should cut out every possible item that can be omitted.

The acceptance of the lowest bid under such circumstances means that the cheapest man, the man with the least knowledge or experience, is entrusted with the duty of providing for the health and comfort of hundreds of persons, and the committee, instead of securing a system, with all the good points in it, have accepted that in which as much as possible has been left out. Surely, it is not to be wondered at, that there are thousands of poorly heated school houses, and almost none which are ventilated.

The proper way to proceed, is to have some competent engineer or architect specify the *results to be obtained*. Then let those who desire to submit proposals for doing the work, specify the exact apparatus they propose to furnish and explain the system they propose to use.

Let it be understood that the contractor must furnish apparatus which will heat the building to 70° F., in any weather, and at the same time, introduce from out-doors and warm a volume of air equal to the cubic contents of the building, as often as every twenty minutes, without causing unpleasant draughts in the rooms, and also expel through the ventilating shaft an amount of air equal to that admitted.

Let it be agreed, also, that the architect shall thoroughly test the working of apparatus and system, and that it is upon his certificate that payment shall be made for the apparatus furnished. Having received the proposals and heard the explanations of the several bidders, select that system which appears to possess the greatest merits, rather than the cheapest one, and the result will prove the wisdom of the choice.

When a building is already erected, and it is desired to introduce new heating and ventilating apparatus, we will make contract direct with the School Board to secure the results specified above. While in all buildings we may not be able to introduce our complete system, we can always secure fair results.

VENTILATION.

We wish to state right here, that what we have to write upon this subject is not original. All the principles set forth have been written about and accepted for many years. We have not discovered anything new though *we have our own methods of applying what is known and accepted as correct to actual practice.*

What we mean in practice by a method of good ventilation, is that system which will, without complicated apparatus, maintain within a building a certain standard of purity of the air, by withdrawing that which is vitiated, and supplying its place with pure fresh air, without causing unpleasant draughts through the rooms.

We do not contend, as many do, that there is and can be only *one* correct system, and then modestly claim we are the only ones who can or do use it.

There are two general systems, based upon essentially different principles, known as the *Plenum* and *Vacuum* methods.

The principle upon which the first is based is: that if a given volume of air be forced into a room, under pressure, an equal amount will be forced out.

The principle of the second is: that if a certain volume of air be exhausted from a room an equal amount of fresh air will come in to replace it.

"NATURAL SYSTEMS."

Both the *Plenum* and the *Vacuum* methods are based upon *natural laws*. Yet neither can properly be called "natural" systems.

The steam engine is based upon natural principles, yet its work can hardly be said to be performed by natural means.

To ventilate a school house or church, it is necessary to lift an immense weight of air in a single day; in other words, *work* must be done and *force* expended, and this work must be done and force obtained by *artificial*, and not natural methods.

There are numerous causes which render the *Plenum* system difficult of application and uncertain in its results, and we, therefore, confine ourselves to the consideration of the principles of the *Vacuum* or exhaust method, on which our system is based.

The requirements of this method are:

- 1st. A vertical shaft or flue, known as the ventilation shaft, to which each room in the building is connected by suitable flues or ducts of proper size and shape.
- 2nd. A means of creating a vacuum, or exhaust draft, in the vertical shaft.
- 3rd. Suitable inlets for the pure air.
- 4th. A means of warming the fresh air.
- 5th. The proper valves, dampers, etc., for regulating and controlling the system. These requirements just mentioned are agreed upon by all writers as essential to a good system of ventilation, but when the question of how to put the system into practical operation in the various classes of buildings, differing as they do in size, material, exposure, location and uses, is considered, authorities differ, and the trouble begins.

It is very generally admitted that the simplest force for moving the large volume of air necessary is gravity. The air in the ventilation shaft is rendered specifically lighter than that in the building by heating it, and is forced upward by the heavier air from the rooms descending and displacing it.

But now comes the trouble. If we ask : "Where shall the warm, fresh air be admitted to the rooms?" one replies, "at the ceiling;" another, "at the floor."

"At what point should the foul air be withdrawn?" again one says, "From the floor, for carbonic acid gas and the exhalations from the body, are one-third heavier than air and settle to the floor." Another, disputes this, and says, "from the ceiling, for the breath, being warmer than the air of the room, rises."

Do we venture to inquire, "What is the best method of heating," we find no lack of answers. The maker of steam heating apparatus assures us that "Furnaces burn the air," "destroy the oxygen," "leak gas," "give a dry heat," "will not work in windy weather," and much more of the same sort.

The furnace men first have it out among themselves, over the question of material. The advocate of "wrought-iron" or, "steel-plate," gravely informs us on "eminent French authority," that "cast-iron is porous and filled with minute sand holes, and when red-hot, permits the free passage of carbonic acid and other poisonous gases through them. The "cast-iron" man retorts on equally good authority, that if "air be brought into contact with red-hot wrought-iron, carbonic oxide, more deadly than carbonic acid, is generated."

Then both unite against their common enemy, steam, and proceed to terrify us with statistics of boiler-explosions. They say, "steam heating is very expensive to introduce, to keep in repair, and for fuel," "steam heating is dangerous to health, because it secures no ventilation." "Radiant heat will not warm a room evenly," etc., etc.

Our criticism of all this is : that while each may understand his own business, he knows very little about the rival system which he criticises so freely. As an instance of this, we quote from the catalogue of a quite prominent "Warming and Ventilating Company," who manufacture Hot-Air Furnaces, or "Air-Warmers," where this statement appears from the pen of a college "professor": "Now heat may manifest itself in two ways, viz : as temperature and as expansion ; * * * * * if a building is warmed by steam three-fifths of the force generated by the burning fuel is consumed in the form of mechanical motion. The "temperature of the steam in the boiler may be 400° or 500° F., but the pipes never indicate over 212°. I have "never found it above 190° F." The utter absurdity of this, is at once apparent, when it is understood that a *temperature* of 400° to 500° F., can only be obtained with a corresponding *pressure* of from 290 lbs. to 350 lbs. on every square inch of interior surface of boiler, pipes and radiators ; while steam heating is usually accomplished with a pressure of from 5 lbs. to 10 lbs. per square inch ; the "safety-valve" being generally set to "blow-off" at about 15 lbs. pressure, or a temperature of not over 230° F.

There are altogether too many "hobbies" ridden in this field of warming and ventilation. Too many get astride some one fact and ride it to death, the while forgetting or overlooking other equally important conditions which tend to offset or neutralize those they are concentrating the force of their intellect upon.

Unbalanced, lop-sided, "systems" are met with everywhere. Ventilating flues are put in buildings and expected to exhaust the air though no heat be applied, and people wonder why the air comes down instead of rising. Or openings are made at the ceiling and surprise is expressed because the rooms cannot be warmed. Others attempt to "ventilate" a room which is heated by direct steam radiation, and wonder why the floors are so cold. All these failures are the result of someone's "hobby-riding." The numerous "systems" which work with reverse action prove the truth of this.

We do not consider that it makes any practical difference whether the breath rises or falls, as to the point at which we should exhaust the vitiated air from a room. We know that the fresh warm air which we admit to the room, rises to the ceiling, and that if we were to make an opening there our purest air would at once escape, and there would be no ventilation. Even if the object be to cool off a room, it ought not to be by

opening registers at the ceiling, but by shutting off the warm air and admitting the cool air, as provided for in our *system of continuous ventilation*.

Air moves, like any other substance, in obedience to force, and if we exhaust the air from the lower part of a room, as we do in practice by the force of gravity, the pure warm air will descend to replace it.

The question of the material—whether wrought or cast-iron—of which a furnace should be constructed is of trifling importance. The principal causes of leakage of gas from furnaces, is the small extent of heating surface and consequent high temperature to which they are raised, and the neglect of the fresh air supply. In the furnace there are two drafts, viz: one up the chimney, the other up the warm air flues. The inner flue is supplied through the grate. The outer flue is intended to be supplied through the fresh air duct, and when that is closed, as it so often is, there is a tendency to fill the vacuum from the fire chamber. The principle is precisely the same as that by which we draw the foul air from a room in our system of ventilation.

A furnace should never, and if one of proper size be used, need never, become red-hot.

We have already stated that it made no difference to us in the matter of profit, which system we employed for heating the building and the air for ventilation. We now state that it makes little or no difference which system we use *to secure the desired results*.

It must be borne in mind that our work is to *both* heat and ventilate the building at the same time. The same heat which warms the building will not also perform the work of ventilating it.

Another thing: We must not secure ventilation at the expense of warmth and comfort, nor must we, as is now generally done, secure the warmth by *sacrificing* the ventilation and health.

We therefore need apparatus which will provide heat, during cold weather, for three distinct purposes, viz.: Heat to warm the building; heat to warm the fresh air for ventilating purposes, and heat to create the exhaust draft in ventilation shaft. In warm weather we need heat for the latter purpose only

THE SOURCE OF HEAT.

We manufacture Warm-Air Furnaces, Hot-Water Heaters, Steam Boilers, Combination Warm-Air and Steam Apparatus, and Combination Warm-Air and Hot-Water Heaters. We can therefore take our choice of apparatus for securing heat for the purposes named above.

For *heating* the rooms quickly and with certainty in all weather, we can get nothing which does the work better than steam.

For warming the very large volume of air necessary for ventilation, and for heating the ventilating flue we can get nothing which will do the work better, or with so little trouble as our Warm-Air Furnace.

When the fresh air for ventilation is warmed by steam or hot-water, it is done by the system of "indirect radiation," or, as we explain in the article on heat, by convection. These indirect radiators are radiators which are placed within fresh air ducts and heat the air as it passes over their surface. The apparatus necessary for perfect control and regulation of this system is quite complicated and much more likely to get out of order than the "air-warmer," or furnace which does the same work. Therefore, taking into consideration all the advantages and disadvantages of each system, including the cost of introducing and maintaining the apparatus, we unhesitatingly declare in favor of the Warm-Air Furnace over steam for all such buildings as school houses and churches where a large supply of pure air is as necessary as warmth.

The best possible system is undoubtedly the one which includes the advantage of both, and leaves out the difficulties, if that were possible. We do not claim to have reached perfection yet, but we have made a long step towards it in our

COMBINATION APPARATUS.

With this we heat the room by direct radiation with steam or hot water, and warm the air, for ventilating, with the Air-Warmer. We thereby retain the advantage we possessed with steam, of heating distant rooms with certainty in any weather, and the advantage of the furnace of being able to warm the pure air without complicated apparatus.

As before stated, we employ either system which seems best suited to the building we desire to heat and ventilate, *guaranteeing and becoming responsible for equally good results with either*, provided people are willing to pay for the necessary apparatus.

OF THE NECESSITY OF VENTILATION,

we say but little, for people are already becoming convinced of the absolute necessity of providing pure air in the school house if their children are to have strong bodies and active minds. Boards of Health, State Boards of Education and State Legislatures are all urging and compelling the introduction of apparatus which will permit a child to secure an education without its health being ruined. People do not so much need to be told what they want as how to get it.

EXPLANATION OF PLATES.

For illustrating as clearly as possible the principles on which our system is founded, we have prepared a series of plates. The difficulty of showing the movement, under varied conditions, of a substance like air, which is nearly invisible, will be recognized by the reader, but a little study will, we think, make clear what we wish to show. We represent the heat and warm air by the red tint, the cold and foul air by the blue tint. The arrows indicate the directions of the currents.

Plate "A" represents the condition of the air in a room heated exclusively by an open fire-place. It will be seen at a glance, what our fathers learned by long experience, that the room is very unequally warmed. The heating is wholly by direct radiation, and the fire-place is at one side of the room. A large amount of air is going up the chimney and its place must be and is filled with cold air from out-doors, thus causing currents of cold air across the floor.

Plate "B" shows the same room, but the fire-place is now used only to exhaust the air from the room while the supply of fresh air to replace that withdrawn, is no longer coming in cold through cracks and crevices, but warm from the furnace. We now have a large volume of warm air which is evenly distributed in all parts of the room. This system is correct in principle and admirable in practice except for the inconvenience of caring for a separate fire in each room.

Plate "C" shows the effect of an opening near the ceiling on the ventilation of a room, and if the building is warmed by a furnace, on the heating also. Our pure air is coming in warm and rises to the ceiling whence it escapes without having changed the air in the room at all. It will be found impossible to heat the room with warm air if the register be open, and it will therefore be closed, and there is no longer an outlet for the air. This is the present condition of very many buildings with respect to ventilation.

Plate "D" shows the same room with opening to vent flue at floor. As our warm and pure air can no longer escape until it has reached the lowest part of the room, the ventilating register may be always open and the room will be evenly warmed and thoroughly ventilated. This method is correct and one we frequently use in buildings already constructed. The only possible criticism of this plan is that the air is all withdrawn at one large opening and too strong drafts may be created.

Plate "E" is used to illustrate several systems. It shows, first, our method of warming and ventilating by warm air from the furnace. It will be noticed that the warm air is admitted at the ceiling instead of the floor. This accords with the true principle, though if the air be admitted at the floor it immediately ascends to the ceiling. By having the warm air admitted at the ceiling a very important difficulty, that of sending warm air to distant rooms, is overcome, for not only is the elevation thereby increased, but the wind can no longer force the warm air back to the furnace.

The plate also shows the system of *heating* the room with steam or hot water by direct radiation and *ventilating* it by fresh air warmed by the indirect radiators or a furnace. The same plate also serves to illustrate the combination system by which *with the same apparatus* we generate the steam or heat the water for *heating* the room and warm the air for ventilating it. This system is correct in principle and has many advantages in practice.

Plate "F" shows our system complete. The warm air for heating and ventilating the room is admitted through the register at ceiling. The foul air is withdrawn through numerous small registers instead of one large one, and carried under the floor to ventilation shaft. By this means an almost uniform temperature is secured in all parts of the room. By the use of furring strips across the floor-joists, as shown in the plate, the free movement of air is permitted in all directions, under the floor.

Plate "G" shows a section of the building for the purpose of illustrating our

SYSTEM OF CONTINUOUS VENTILATION.

When Warm-Air Furnaces are used, the warm air for heating is also the fresh air for ventilating. If the room becomes too warm, the register is closed to shut off the heat, and that shuts off the fresh air also. Our system is so arranged that the air supply cannot be shut off, though it can be introduced either warm or cool as desired. Referring to the plate: "A" is the warm air chamber or furnace room; "B," "B" are the outlets for cool air from the air-ducts; "D," "D," "C," "C" are outlets for the warm air into the flues leading to the several rooms.

The temperature of the room is controlled by opening or closing the dampers at "C," "C," by means of the lever "S," which is placed in a convenient location in each room.

The damper at left of warm-air chamber "A" is shown closed so that only cool air is admitted to the flue, while that on the right is partially opened, and both warm and cool air are obtained in the proportion desired. It will be observed that if the heat be entirely shut off from the school rooms the flues are still open to the air-duct "D," and the fresh cool air is drawn in to replace that exhausted by the ventilation shaft.

SUMMER VENTILATION

is frequently neglected even where some attempt is made to supply fresh air when the furnaces are in use. Our system provides for the admission of cool air during the warm weather without the necessity of opening windows.

THE PATENT AUTOMATIC AIR-VALVE

shown at "E," is a very important part of the apparatus comprising our system. Simple as it is, it perfectly controls the supply of air required for ventilation and warming. Its great value is due to the fact that it takes out of the hands of the janitor the work requiring the most intelligence and best judgment, and does automatically what the janitor frequently fails to do at all, and never can do as well. By the use of this air-valve, the volume of air admitted is *always the same* whether it be windy or calm weather. The importance of the air supply is fully shown under the head of "Convection." This device is fully covered by letters patent.

Plate "H," is an isometric drawing of basement plan of school house, showing the manner in which we use the foul air from the building to serve a very useful purpose before it is finally expelled by the ventilation shaft. The arrows, if carefully followed from the air-duct "h" to ventilation shaft E, will indicate the course travelled by the foul air. Entering at the air-duct, the air passes to the warm-air chamber "A," from which it is distributed through the building, by the flues "a," "a," "b," "b." Having passed through the rooms it is withdrawn through the ventilating registers and brought back to the basement into the foul air gathering room, "B."

From the foul air room "B" the air passes through the openings "e," "e," beneath the seats of the privies, and there evaporates all moisture and carries off all odors.

THIS DRY CLOSET SYSTEM

has been introduced into many school houses by the "Ruttan-Smead Warming and Ventilating Company," and is a success. We have simplified and improved upon their methods as they improved upon the methods of others, and we claim for our system great advantage over any yet practically introduced for water-closets or privies.

THE SMOKE FLUE

is usually built within the ventilation shaft, and when the furnaces are in operation, generally heats the shaft sufficiently without the use of the small furnace which is set at the base of ventilation shaft for use in summer, or when the heat from the chimney is insufficient to secure a strong circulation of fresh air.

Plate "I" is an isometric drawing of our complete system as introduced into the new school house erected in District No. 4, Johnstown, New York.

The drawing shows one end of the building cut away to give a view of the automatic air valve; the fresh air duct beneath basement floor; the warm air chamber in which furnaces are to be placed; the openings for warm and cool air to flues leading to school-rooms; the foul air flues to dry closets; the small furnace in foul air room and the ventilation shaft and smoke flue.

By following the course travelled by the air as indicated in the cut by the arrows, it will be seen that it enters the building through the automatic air valve, which controls the volume admitted, passes thence to the warm air chamber where it is heated and sent up to the several rooms on first and second floors, where it does its work of warming and ventilating.

After serving this purpose, the process of ventilation is continued by withdrawing the air through the numerous small registers placed about the room in the base board, from whence it passes under the floor to the ventilation flues which carry the air back to the basement, where, as previously explained, it is used to evaporate the deposits in the closets before it finally passes to the ventilating shaft and thence out of the building.

We thus secure by this means a constant current of fresh air through the building, and this action is positive and reliable. If the flues be of proper size and the system properly introduced, there will always be the same positive currents and certain results *in any weather* if the ventilating shaft is heated.

THE MAHONY "AIR-WARMER" OR FURNACE,

For school house and church work, is constructed with a view of bringing the largest possible volume of air in contact with the furnace.

In constructing a furnace, the following points must not be overlooked :

1st. The purpose of the furnace is to *warm air*.

2nd. Air can be warmed by *contact* only.

3rd. The volume of air which can be warmed, at the same instant, depends upon the extent of the warm surface with which it can be brought in contact.

4th. There is no practical gain in *heating power*, while there is a great loss in the *quality of the air*, from having a very high temperature in the furnace.

Dulong records the results of his experiments as follows : "With *radiation* the higher the temperature of the heating surface the greater the proportion of the heat given out for each degree's difference between the heated body and the surrounding air."

"But with *convection* the yield per degrees difference is for all practical purposes, irrespective of the absolute temperature of the heated body, or of the difference of temperature of the heated body and the air in contact with it."

"With a *radiant* body at a clear red heat of $1,015^{\circ}$ C, the amount of heat transmitted per meter per hour is about 300 times that transmitted at 100° C, and at a white heat of $1,415^{\circ}$ C it rises to 4,604 times that amount."

"With convection, however, the difference in loss of heat per degree is comparatively slight. Supposing that with the heated body at 0° C, and the air at 15° C, the loss by contact or by radiation were 1, at 250° it would be by contact only 1.9, while by radiation it would be as high as 3 ; at 310° , 510° , $1,015^{\circ}$ and $1,415^{\circ}$, the loss by contact would be 2, 2.3, 2.7 and 2.9 respectively, while by radiation it would be 4, 13, 300 and 4,604 times greater respectively than at 0° C."

5th. For a given amount of fuel the same amount of heat will be generated by combustion, whether the combustion be slow or rapid. The value of a furnace will therefore depend upon the amount of heat saved and imparted to the air by it compared with that lost through the smoke flue, and the amount of heat saved will depend upon the extent of heating surface, and the rapidity of combustion.

*Though a furnace may have considerable extent of surface, it may still be so constructed so that the loss of heat will be great from too rapid combustion.

Consideration of these facts proves conclusively that it is not the furnace, which by its "superior construction, concentrates the heat," nor the one in which an "intense heat can be quickly obtained," but that which spreads the heat most evenly over the largest extent of surface, which is the superior one. In other words, great extent of heating surface with slow combustion, are the points to be sought for.

The cost of fuel necessary to generate the heat in the furnace is a matter of considerable importance since it is a perpetual expense. It frequently occurs that extra money invested in superior heating apparatus will be quickly offset by the fuel saved.

The kind of fuel used largely determines its cost of course. Good anthracite coal is generally the best and cheapest fuel to use. Indeed bituminous coal ought to be very much cheaper to compensate for the extra labor necessary in using it, from the fact that apparatus for burning soft coal must be cleaned very frequently to prevent the flue becoming choked with soot.

PLATE A

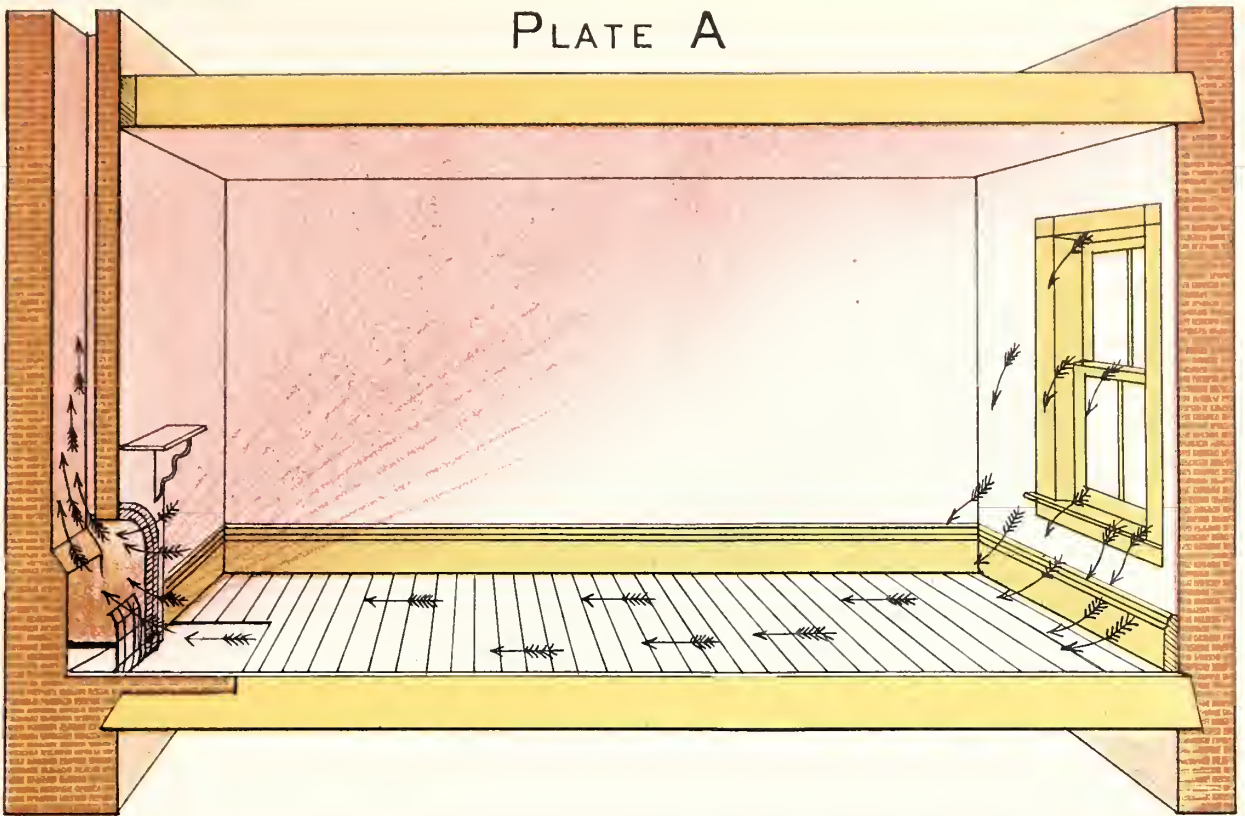


PLATE B

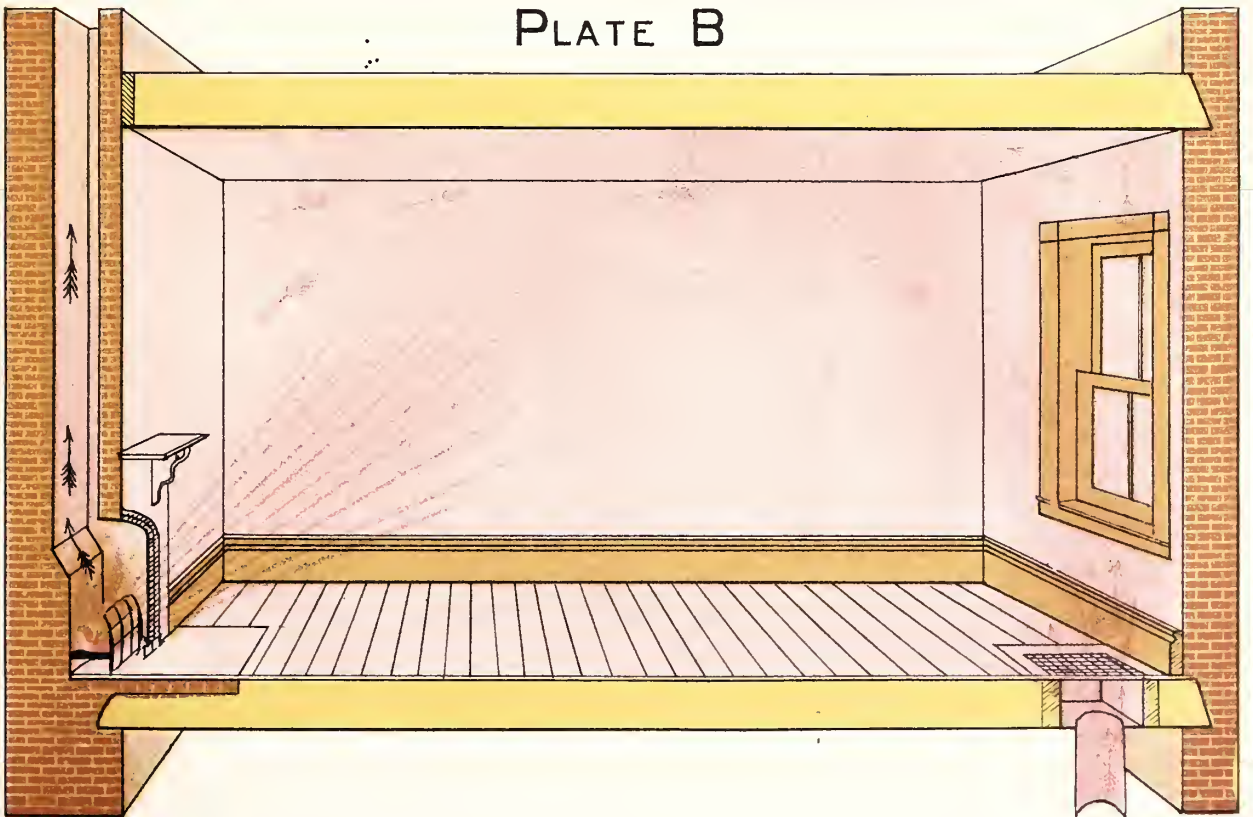


PLATE C

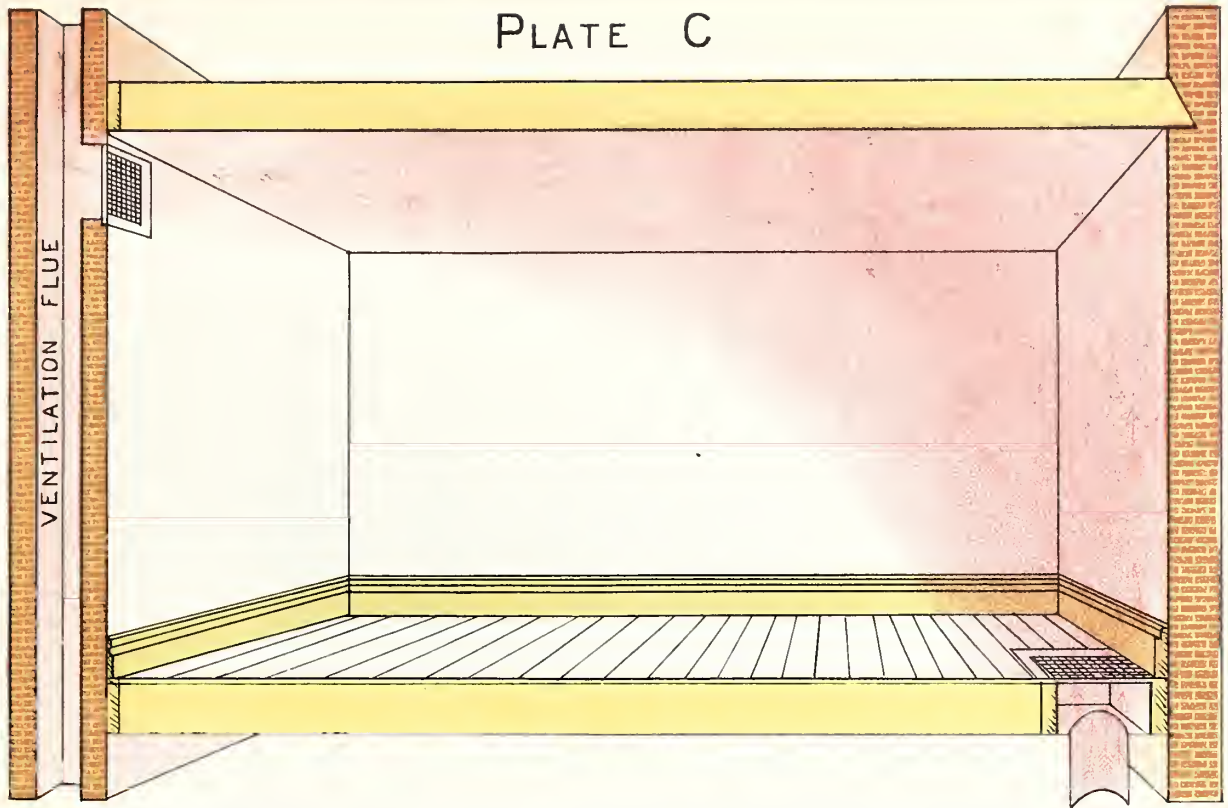


PLATE D

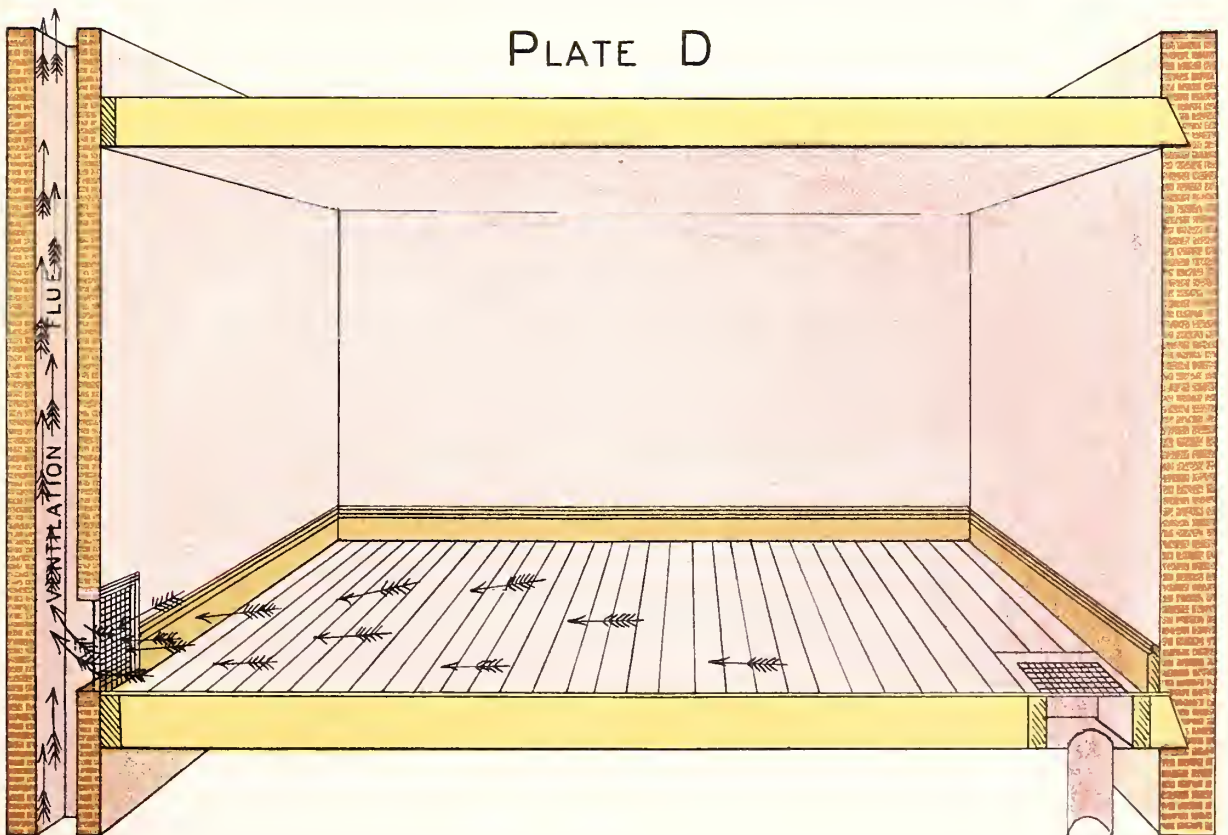


PLATE E

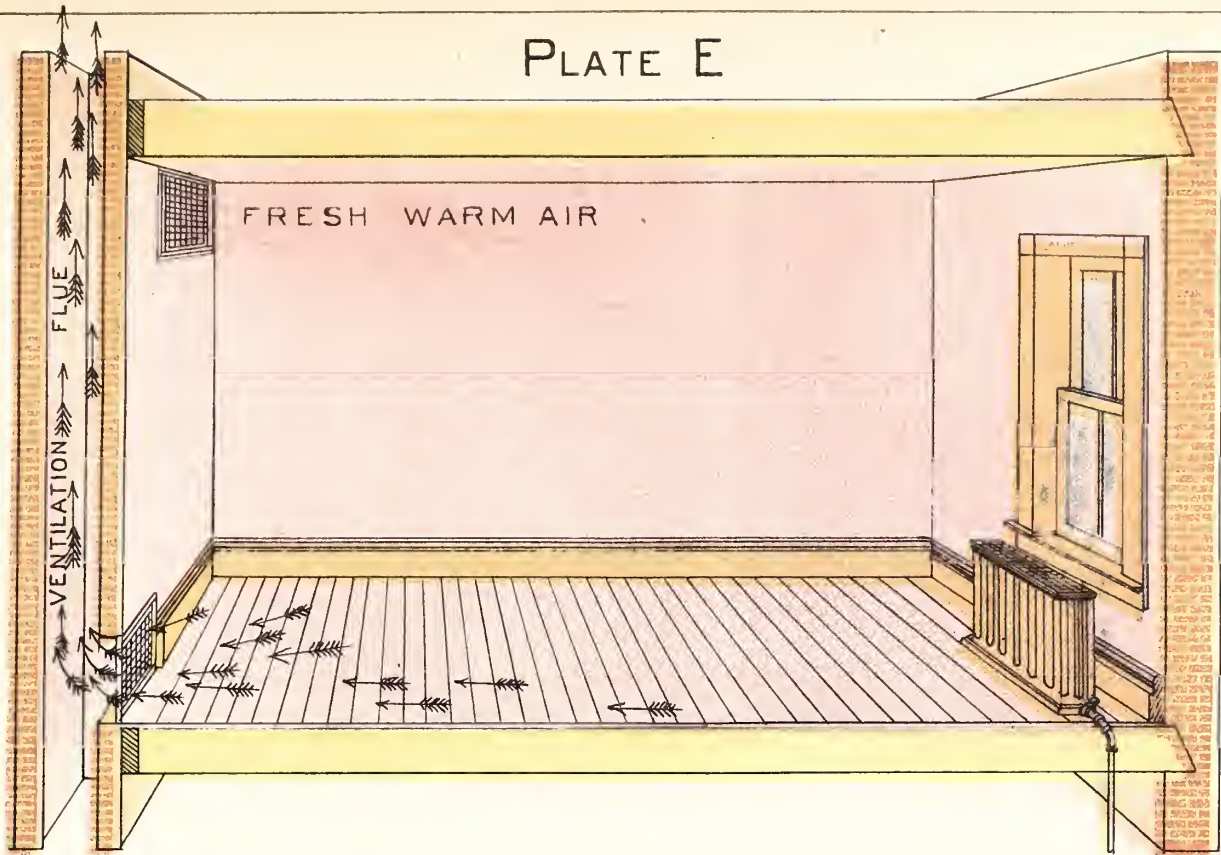


PLATE F

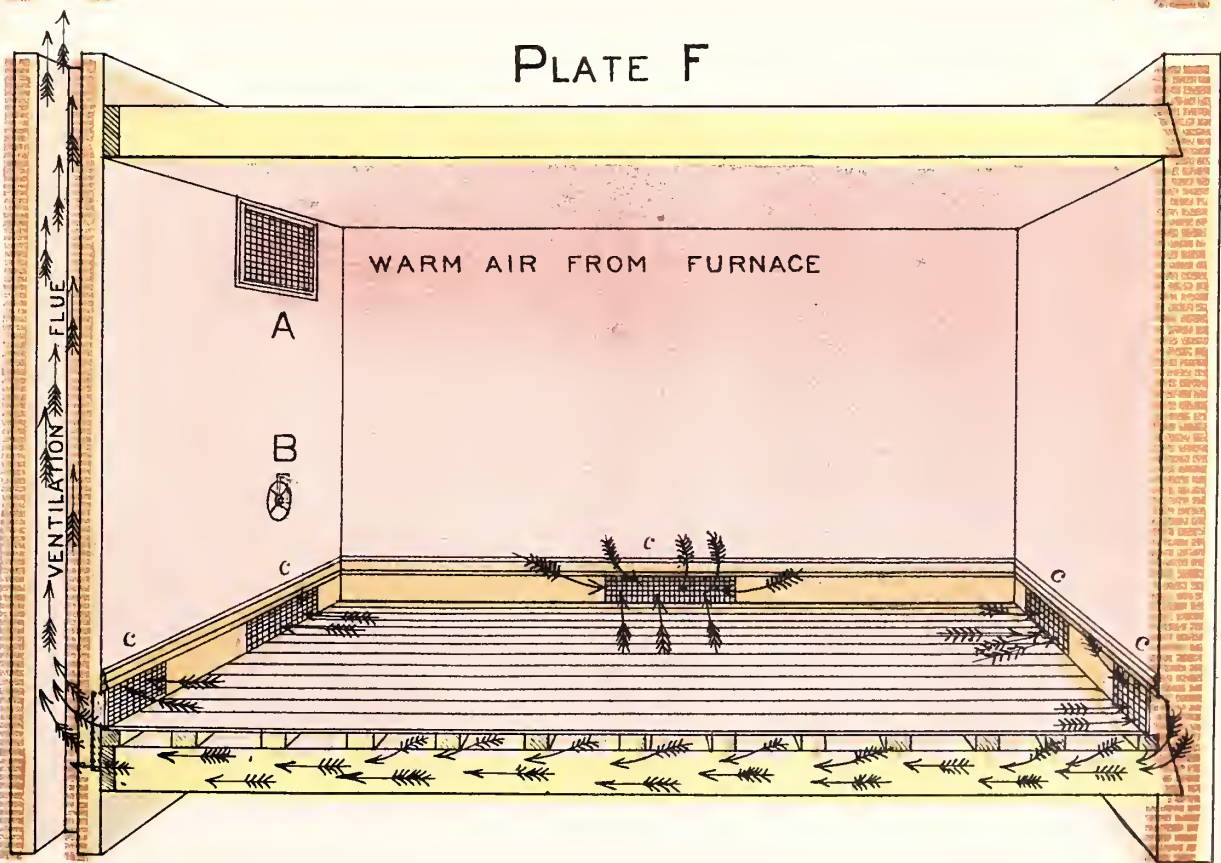


PLATE G

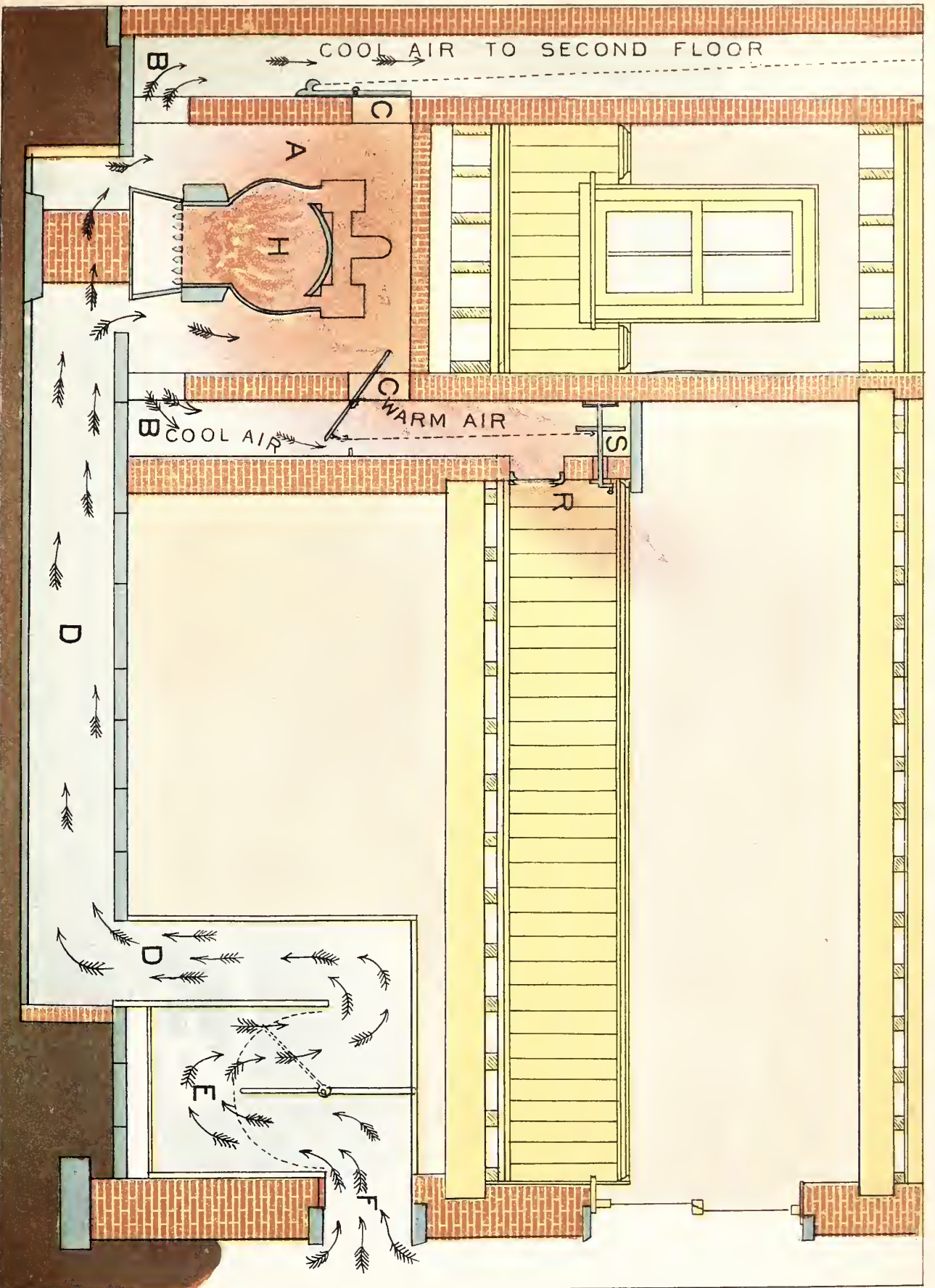


PLATE H

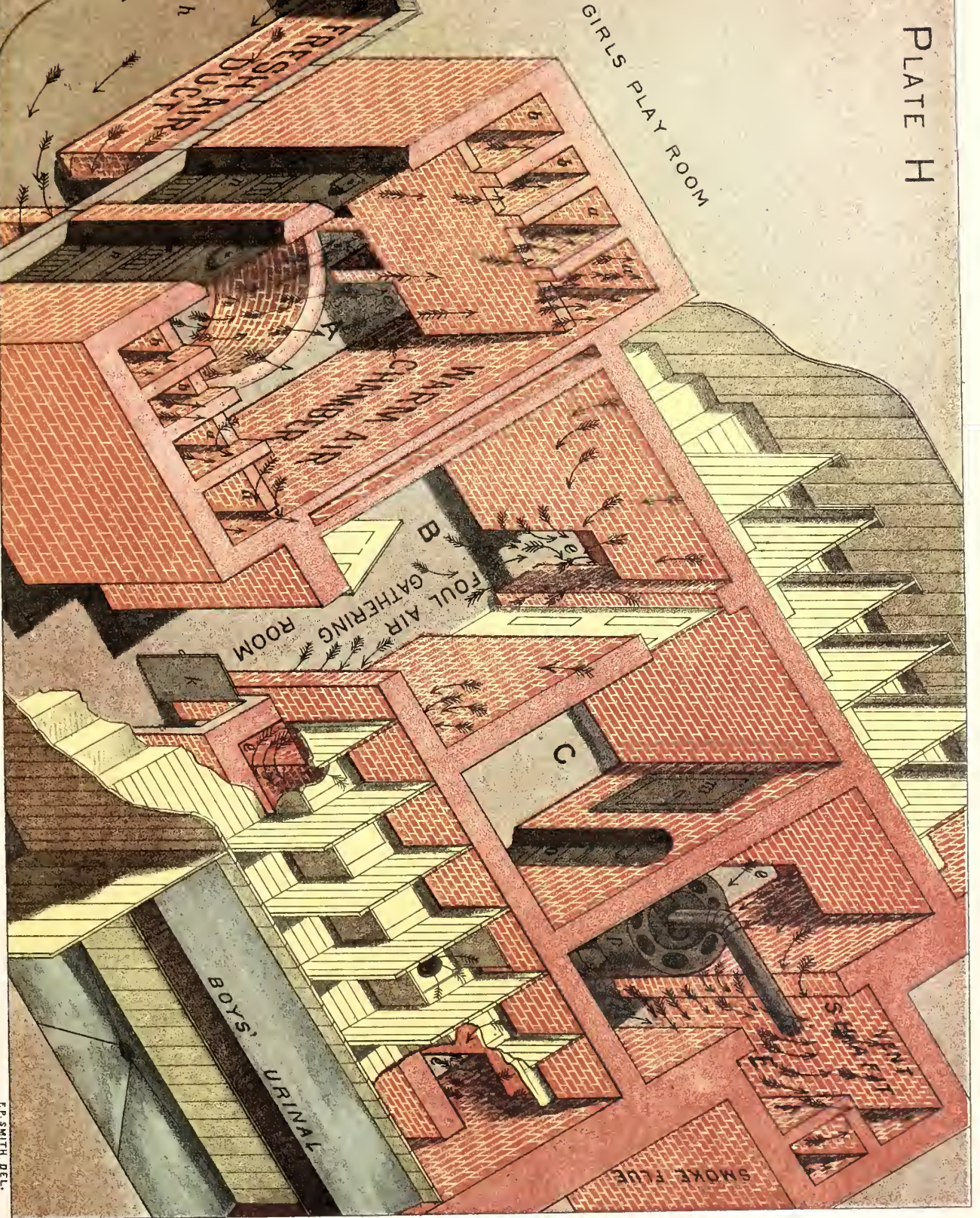
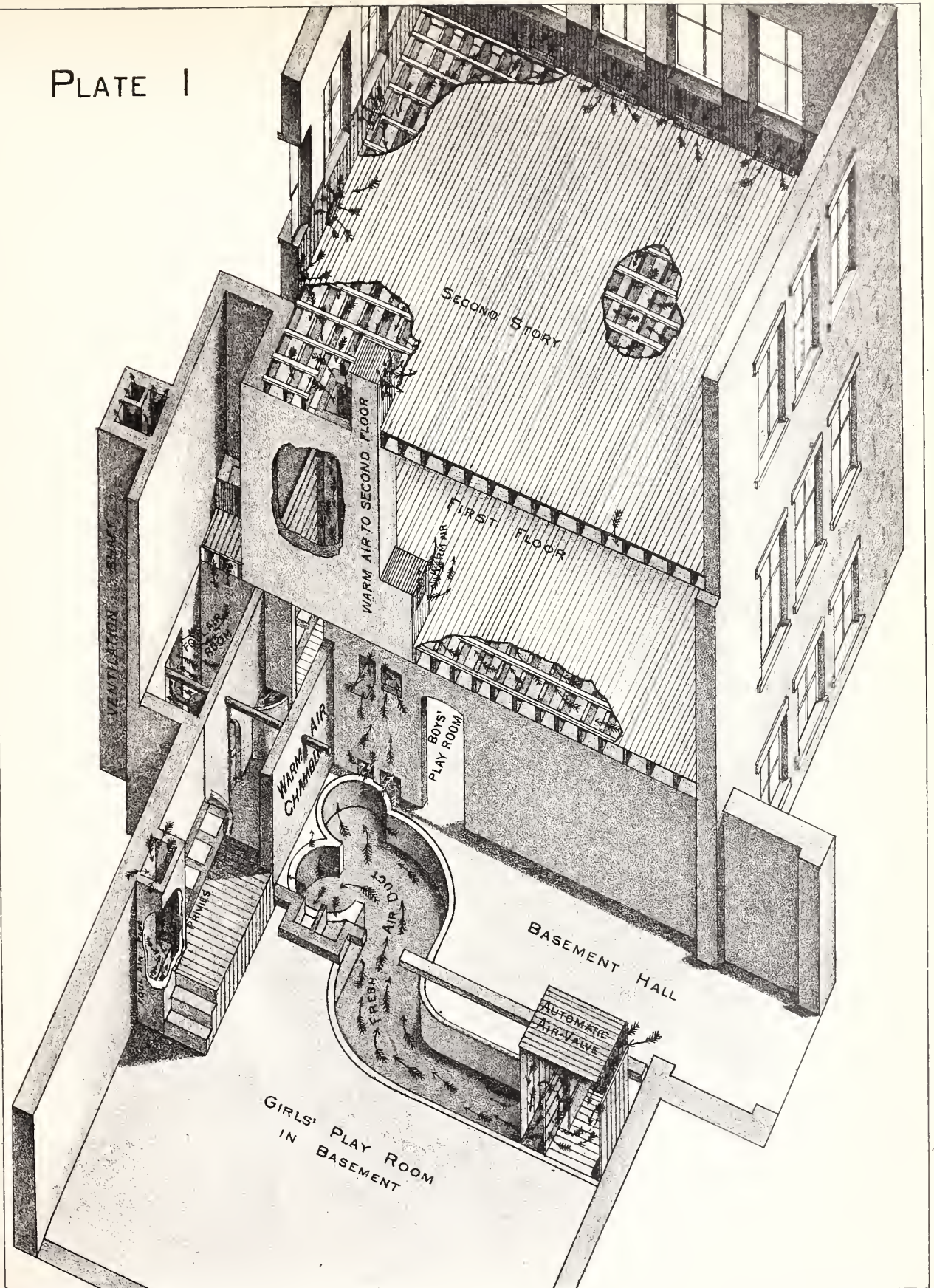
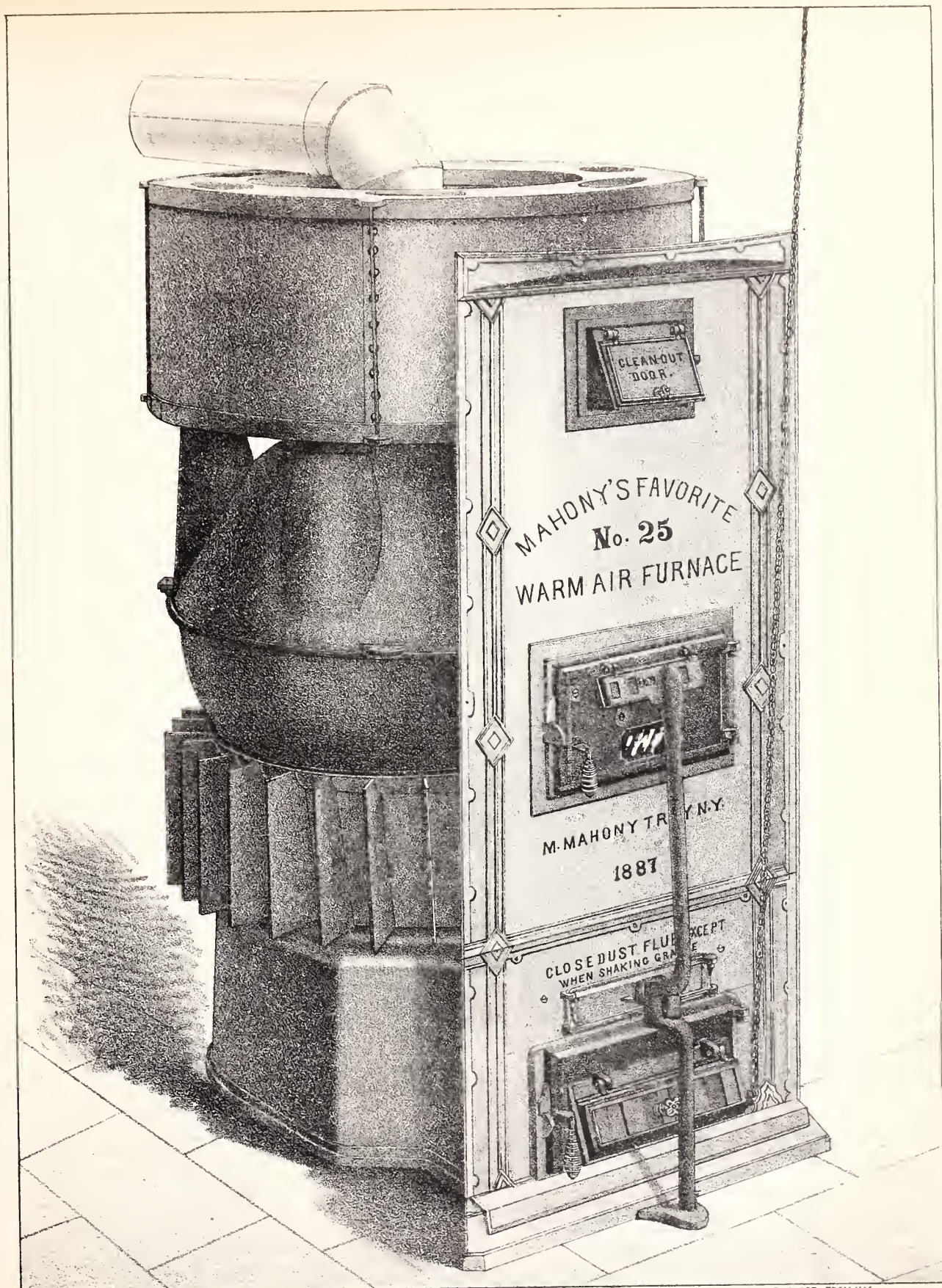
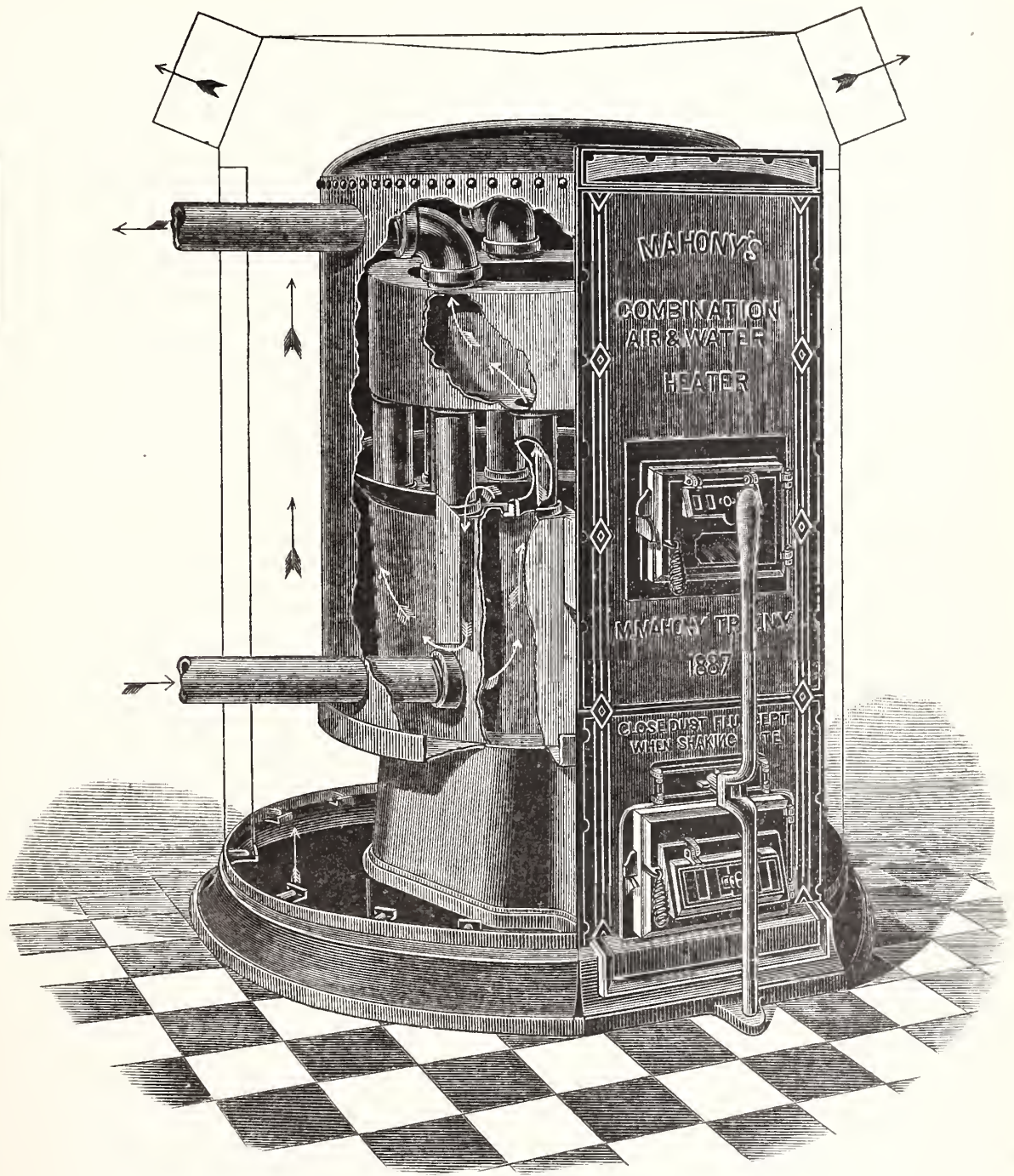
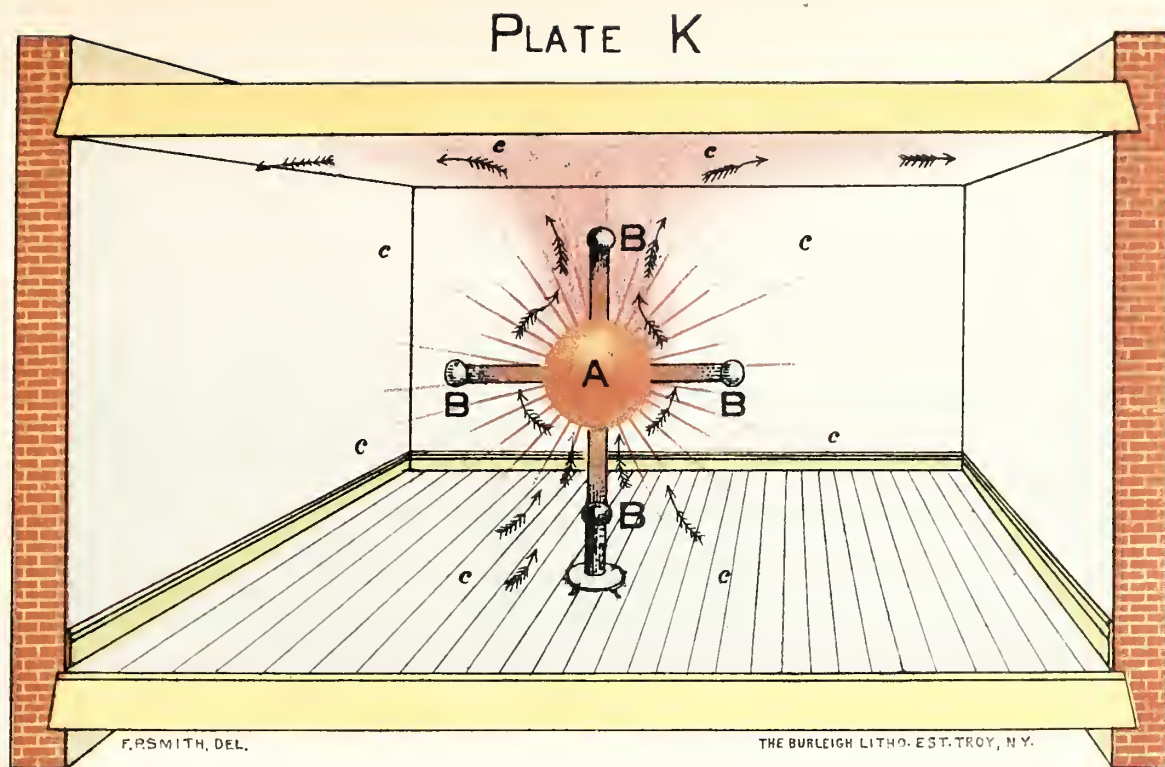


PLATE I









HEAT.

It is not the purpose of this article to go into any elaborate theorizing as to what heat is. Indeed, we would much prefer to leave out theory altogether, were it not for the fact that this work is especially addressed to those interested in educational matters, and who, therefore, wish to understand the "reason why" for the facts we set forth. We are somewhat diffident about telling all we know on this subject, for fear we may, like some of the "authorities" on warming and ventilation, inadvertently expose how much we do not know. Leaving others, therefore, to settle the question of what heat *is*, we propose to consider what heat *does*, and *how it does it*.

To make as plain as possible the different ways in which substances receive heat, or the different manners in which heat spreads from a heated body, we have prepared plate K, above.

We represent here a metal globe, "A," through which are passed a vertical and a horizontal rod; on these rods, equi-distant from the center of globe, small balls (B B B B) are placed. From the globe in all directions, radial lines (c c c c) are shown. The cool air of the room is shown in the blue tint, and the hot surfaces and warm air are represented by the red tint.

CONDUCTION.

Heat spreads *through* substances, from particle to particle, with a velocity proper to each substance.

Heat so diffused, is called conducted heat. It is by conduction that the heat from the fire in the stove or furnace, or, from the steam or hot water in the radiators, passes through the metal, and is brought to the outside.

All solids conduct heat more or less rapidly ; the power of conduction depending largely upon the density of the substance ; thus silver conducts heat about five times as well as brass, and brass about twice as rapidly as iron. Many substances such as fire-brick, mineral wool, asbestos, etc., are commonly called non-conductors, and are used to prevent the spread of heat by conduction, though they too conduct heat, but in a low degree.

Liquids, because of the mobility of their particles, do not conduct heat readily. Water is an almost absolute non-conductor of heat, though if its free movement be obstructed by anything like starch or glue it will conduct slightly.

Air is probably the worst conductor of heat known ; that is, it is the substance which when at rest, impedes the passage of heat most. The double casing on a furnace, or double windows on dwellings, are examples of the prevention of the loss of heat, by a thin layer of air.

Heat is diffused by conduction equally well in all directions. Referring to the plate, it will be seen that the balls B, B, B, B, are heated by conduction equally from the hot globe "A."

RADIATION.

Heat spreads also by being radiated or transferred from one body to another through transparent substances or empty space, with a readiness which is governed by the material and state of the giving and receiving surfaces.

Like conducted heat, radiant heat spreads equally in all directions and the same law of intensity governs both, viz : it decreases in intensity according to the square of the distance of heated solid ; i. e., at two feet its intensity is reduced to one-fourth, and at three feet to one-ninth, etc.

Radiant heat possesses the property of passing through many substances without affecting their temperature. Thus sufficient radiant heat may pass through and be concentrated by a lens made of ice to ignite gunpowder placed at the focus of the lens, and yet the ice is not melted, because it has not intercepted and absorbed the rays of heat.

Many instances of this property of radiant heat to pass through solid substances might be given but it is not necessary to do so here.

Liquids absorb and become warmed by radiant heat to some extent.

The effect of radiant heat upon air is the point which most concerns us practically, and we find by investigation and experience, that *radiant heat passes through air without affecting its temperature at all*, if the air be dry.

Air, therefore, cannot be warmed by radiation. This fact has a most important bearing upon the construction of "air-warmers" or furnaces, though it is frequently overlooked by those who manufacture such apparatus.

The surface of a substance greatly influences its capacity to radiate heat, or to receive radiated heat. Thus cast-iron, if it has a rough surface will quickly absorb heat, while if its surface be polished it will reflect most of the heat rays, instead of absorbing them.

The greater the capacity of a substance to radiate heat, the greater also its capacity for absorbing it and becoming heated.

All bodies radiate heat, whether they are above or below the temperature of the medium in which they are placed. Thus, heat-rays are radiated by boiling water, a red-hot ball, or a cake of ice, and this radiation goes on until an equilibrium of temperature is reached.

CONVECTION.

Heat spreads in fluids by the transference of their particles, or convection.

The term "convection" means carrying or transporting. The heat which is taken up by the particles of a fluid, in contact with the hot surface and carried away, is called convected heat. This principle of convection is one not commonly understood by those who construct and introduce warm-air or hot-water apparatus, though it is the foundation principle of their work.

It is a commonly accepted saying, that "heat rises," but this is not strictly true. It is not true of conducted heat, nor of radiant heat, for they spread equally in all directions, and it is only true of convected heat, to say that it *rises*, when it is *carried* by some substance, as air or water. Heat is not a substance. It has neither volume nor weight, and no existence separate from some substance, and therefore cannot be said to rise or fall. We call attention to these points only to bring out the fact, that if heat is to be carried, a *carrier* is necessary. In the hot-water system the water is the carrier, and as it circulates through the boiler it receives heat, and carries it to the radiators where it is given out.

In the warm-air system *air* is the heat carrier, taking up and carrying the heat just as the water does.

It is just as sensible to expect to heat a building through the pipes of the hot-water system if the water be not supplied, as to expect to warm a building through warm-air flues if the air be omitted. The common complaint in school houses and churches, in fact in the use of furnaces generally, is : that "though there is a hot fire and the furnace is intensely heated, yet the heat won't come up."

It is not our business to point out the remedy for this trouble just mentioned, but we will guarantee that wherever we contract to heat a building with warm air, we will furnish apparatus which will automatically control the air supply, and that the heat will always "come up."

There is a general misuse of the term "radiation," and a misconception of its meaning. We speak of a steam "radiator," when as a matter of fact, the principal work of the "radiator" is done by convection or the taking up of the heat by the air which comes in contact with the surface of the "radiator."

The term "Indirect radiation," is used to express, in steam heating, or hot-water heating, what is really "convection," and not "radiation" at all. Heat is spoken of as "radiating" through cast or wrought iron, when, of course, it goes through metal only by conduction.

The open fire place warms a room by direct radiant heat alone.

The ordinary stove heats principally by radiation, and slightly by convection.

The "direct" steam radiator heats almost wholly by convection, and only slightly by radiation.

The indirect steam radiator warms by convection only.

The warm air furnace heats by convection only.

Since the fire place and stove heat by radiation, a room cannot be evenly warmed by them.

With the direct steam radiation, a room can be heated quite uniformly, but ventilation is entirely lacking.

With the "indirect radiation," and the warm air furnace, an even temperature and good ventilation can be secured.

The great advantage obtained at present by indirect radiation over the common furnace, is in the amount of surface used to warm the air. For instance, to warm a school house of, say, eight rooms, each containing about 8000 cubic feet, would require not less than 1600 square feet of heating surface if indirect steam radiation were used, while there would not be over 200 square feet in the two common furnaces which would ordinarily be used to heat the 64000 cubic feet of space. This subject is more fully considered under the description of our furnace, which is especially designed to overcome this difficulty.

THE "MAHONY'S FAVORITE" FURNACE,

of which a view is shown on page 25, is constructed especially for the heavy work of heating and ventilating public buildings, where a very large volume of air has to be warmed, and the apparatus is to be under the care of the janitor.

The average janitor is not apt to be very careful of the furnaces he cares for, and apparatus placed in his charge needs to be very heavy and strong if it is to prove durable. The simple construction of the Furnace renders it easy to care for and keep clean. This is a very important matter and one frequently overlooked. The strongest guarantee as to heating and ventilating may be filled with apparatus which may be neither durable nor convenient to keep clean and in good working order.

With ordinary good care our Furnaces will run for years without the expenditure of a cent being necessary for repairs. A burned out grate can be readily replaced by a new one without disturbing the Furnace.

As our Furnace is now constructed, if the proper supply of fresh air be admitted, *it cannot be made red-hot*; the flame and products of combustion being distributed over so large a surface that the air takes up the heat as fast as the burning fuel generates it.

There is considerable prejudice at present against furnaces, which some manufacturers seek to avoid by calling their furnaces "air warmers;" but the "air warmer" is still a furnace and the furnace ought to be an "air warmer."

Nearly all the furnaces on the market are built on the same general plan; being designed to heat a small volume of air very hot. Our whole aim is to produce a furnace which will heat as large a volume of air as possible to a temperature of not over 150° F. With the common furnace it requires many hours to heat the lower part of a church though the temperature at the ceiling may be very high. We have frequently found a difference of over 100° F. between the temperature at the ceiling and three feet from the floor after common furnaces had been running for hours, while with our system we can heat the building in the coldest weather in from three to six hours and not have a difference in temperature of over 10° F. between ceiling and floor.

THE COMBINATION HEATER,

of which we show a cut on page 27, is the most powerful and economical apparatus yet placed before the public. The idea of combining in one heater a warm air furnace and a steam or hot water boiler, is not new, but all efforts to produce such a combination heretofore have resulted in a very complicated and expensive, though successful apparatus.

It will be seen at a glance how simple and free from joints is the heater we produce. The boiler consists of the fire pot of the Furnace, which is hollow and cast in one piece, and an upper section also in one piece, the two being connected by several pipes having "right" and "left" threads. The fire pot being always filled with water, is practically indestructible since it can never become red-hot. The whole boiler is enclosed in a steel plate or wrought iron drum which forms the heating surface of the Furnace. The full arrows show the direction of the currents of warm air and products of combustion, and the half arrows the direction of the currents of water through the boiler. *There is not a packed joint in the boiler*, and the Furnace is warranted gas-tight.

Careful experiments show that with the strongest fire we succeed in reducing the temperature of the smoke flue to the lowest limit consistent with a good draft. The same fire and the same amount of fuel will do much more work in the Furnace and Boiler combined than in either used separately.

This Combination is much better for schools and churches than either steam or hot water—costs less to introduce, and much less to maintain. The *heating* being done by the Boiler and the ventilating by the Furnace.

OUR GUARANTEE.

Whenever we make contracts for warming and ventilating buildings; the parties with whom we contract are at liberty to have an agreement drawn up by any one they may choose, covering the points of the contract. If that is not done we give a guarantee as follows :

"WE hereby guarantee that the apparatus furnished for warming and ventilating the..... located in..... has sufficient capacity to, and will, with ordinary good care and proper attention to fires, regulation of drafts, fresh air supply, etc., heat said building, or such parts thereof as contract covers, to a temperature of 70° Fah. in any weather, and ventilate the building to the extent that the air shall be changed as often as..... times per hour. The temperature in all parts of each room shall be uniform at the same height from floor, and all parts of building, covered by the contract shall be warmed and ventilated at the same time, unless otherwise expressly agreed.

If, after proper tests, the apparatus furnished cannot be made to secure the results guaranteed, we agree to refund the money received for same, remove the apparatus from the building and repair all damage to building caused by the introduction and removal of our apparatus."

TO BOARDS OF EDUCATION.

If for any reason you are considering the subject of warming and ventilating your school houses, whether new or old buildings, it will benefit you to correspond with us before coming to a decision as to the methods and apparatus you will use.

No part of your work is so important as providing comfortable and healthful school buildings, but without a successful system of warming and ventilation, the finest school house is simply an exhibition of folly.

Remember this : We will make a contract with you to secure the results you want in such a manner that even if we were to fail entirely to fill our guarantee, there could be no loss or damage to you. Hoping that this work has sufficiently interested you to induce you to correspond with us, we are

Very Truly Yours,

THE MAHONY WARMING AND VENTILATING ESTABLISHMENT.

TROY, N. Y.

